# Pioneer Venus Multiprobe Entry Mission Support

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*The support of the Pioneer Venus Multiprobe entry event by DSS 42/43 is described. Support included aiding in procedure development, determining staffing requirements, equipment checkout, and determination of final detailed station configuration.*

## I. Introduction

The Pioneer Venus Multiprobe entry represented one of the most difficult challenges ever presented to a deep space station. For a critical five-hour period, the success of a major planetary mission literally rested in the hands of the DSN Goldstone and Australian 64-meter stations. The operational complexity of the event for the stations dictated more extensive participation by station personnel in the mission support planning and significantly more testing and training than is usually required by a planetary encounter. The test and training activity was, in the view of DSS 42/43, more extensive than for any other event supported by this complex, except perhaps for Apollo support.

The following describes the station support from the viewpoint of station personnel in preparing for the entry event on December 9, 1978. The report is divided into three sections, corresponding to the organizational structure at Tidbinbilla: Operations Section, and Engineering Group Data Acquisition Section and Data Handling Section.

## II. Operations Section

The involvement of this station's Operations Group in the Pioneer Venus Probe mission began in February-March 1978 with the participation of two shift supervisors (Ben Ryan and Dave Hollingsworth) at JPL in the generation of the preliminary station countdown and operational procedures and a detailed sequence of events. During their visit, the preliminary procedures were tried out at DSS 14, using the actual entry configuration (minus a few minor pieces). The five days of testing at DSS 14 convinced everyone involved that this mission really was going to be something different and would require extraordinary participation by a large number of people at the supporting stations.

Upon returning to Australia, the sequence of events and the project requirements were studied and discussed; out of this came the decision to amalgamate two of the four operations shifts into one large, 16-man "Probe Entry" shift. The delivered entry station configuration was also studied and several minor changes requested: time readouts to be added to the

Spectral Signal Indicator (SSI)/Subcarrier Demodulator Assembly (SDA) area and relocation of the Block III Receiver Program Oscillator Control Assembly (POCA's) to simplify the receiver operations. In September, an Engineering Change Request was generated to permit S-band maser switching while uplinking as part of the failure/recovery contingency plan.

The first "in-house" attempts at the entry sequence were very ragged; the Multiprobe simulator design and the telemetry simulation tape gave us a few headaches (spontaneous random frequency shifts, Large Probe not being keyed on by data appearance, etc.). These problems were gradually resolved, and we entered the combined operational verification tests with DSS 14 in August with a good knowledge of this equipment's idiosyncrasies. However, the simulator was less flexible than we would have desired, but indispensible in preparing for the Entry.

During the testing and training period, some 14 Pioneer Venus related Engineering Change Orders were implemented and, in addition, the DSN Mark III Data Subsystems software went through numerous revisions. Procedures were implemented on site to retain timely station response to mission test requirements during this difficult period. Programs were written for the HP 9810 in lieu of the SSI microcontroller to permit the closed-loop receivers to participate in these early tests in a realistic manner. These programs enabled the rapid conversion of frequencies determined with the SSI into the proper level for the closed-loop receiver operator input.

Operationally, this station was concerned, from early in the year, with the planning for contingency/failure support. Initially, it was thought that the activity level during the entry would be too high to permit recovery action without possible confusion affecting the receipt of other data. However, as repeated operational verification tests increased operator proficiencies, the problem did not appear so intractable. Possible reconfigurations were small in number as most normally redundant equipment would be in use. However, by early November, priorities of data streams had been determined and agreement reached on a failure recovery strategy.

In May, concurrent with the ongoing probe entry support activities, DSS 42 supported the operational readiness test, the configuration verification test, and the launch of the Orbiter. New communication and monitor format and telemetry processing assembly software introduced just prior to launch required JPL task team formulation to resolve deficiencies. Short notification and late documentation was experienced in the prelaunch period. During the week prior to launch, DSS 42 antenna oscillations in tape drive mode caused some concern and was the subject of intense investigation. The anomaly was never fully resolved.

During June, the Multimission Receiver (MMR)/Digital Recording Assembly (DRA) subsystem underwent considerable testing in support of the DLBI wind experiment. MMR phase stability caused concern, as did the DRA performance, for the next five months. Operationally, the stream of operational verification tests, performance demonstration tests, mission operations tests, and DLBI tracks was very extensive.

The launch of the Bus on August 8 was supported by DSS 42 in a nominal manner – the only significant problem was a failure in the autotrack reference channel at the time of uplink acquisition. Tape drive was selected and only a momentary telemetry outage occurred.

MMR phase stability continued to cause concern until September, when a revised Engineering Change Order, 77.183A, was implemented. The DRA problems were straightened out, and confidence in our DLBI support improved as the station exercised the radio science equipment with other missions.

Also by September, the third SSI was in operation, and we could get acquainted with the microcontroller mode of operation. The microcontroller was found to be disappointingly slow in action – much slower than using our own software in the HP 9810. Procedures were established between the operators that obtained proper closed-loop receiver lockup. The rapid integration of the SSI into the normal operational environment of this station seemed to be another illustration of the "law of inverse effect" – put an interesting, sophisiticated piece of equipment into the operations room, don't provide much in the way of information about it, and we achieve maximum operational cognizance in the minimum of time.

Entry preparations stabilized in November with the final operational readiness test and operational verification test, although new communications and monitor format and DSN Mark III Data Subsystems software were used at this late stage due to the requirements of other missions. Support on these tests was mostly nominal; however, sequential decoder lock times and Block IV exciter POCA performance caused concern. The station's pretrack preparation plan, including the detailed -3 and -1 hour check lists, was published, and engineering section support requirements were determined.

## III. Engineering Group

### A. Data Acquisition Section

Activity to support Pioneer Venus started early in 1978 with an effort to install sufficient hardline on the tricone of the 64-meter antenna to accommodate the additional front-end equipment required to support the Entry event. An early start was made so that use could be made of small portions of antenna time as they became available and station stocks of spiroline were used; thus the installation on the tipping assembly was completed without any scheduled downtime. A similar approach was adopted for tricone equipment in that unistrut supports were installed well ahead of time. Knowing the dimensions of the items to be installed, a minimum of downtime was then required for the installation of the tricone equipment.

Proposed location of control room equipment went through a number of alternatives before a satisfactory arrangement for operations was achieved. Actual installation of the RF equipment progressed quite smoothly both in the control room and on the antenna.

The testing phase revealed some problems. The most noticeable one was poorer phase stability of the MMR than expected, and this was eventually improved by removing an amplifier which was running into saturation.

### B. Data Handling Section

The major activity in support of Pioneer Venus operations was the installation and checkout of the digital recording assembly recorders.

Recorder A arrived in mid-January, followed by Recorder B in mid-April. On completion of equipment installation, acceptance testing was intitiated. At this point it was discovered that Recorder B was set up to a Seasat specification and required a complete realignment. Acceptance tests were completed on both recorders by the end of June.

Although the tests carried out on site were successful, subsequent network recording tests revealed an incompatibility between the CTA-21 and DSS 43 recorders. Data recorded at DSS 43 could not be replayed with an acceptable bit error rate at CTA 21, while error rates from DSS 14 were very good.

This was a head alignment problem, and in October a calibration tape was sent from CTA 21 to be used as a reference against which the recorder heads at DSS 43 could be set up. After realigning the recorder heads, test data from both recorders was shipped to CTA 21 and successfully validated. Notification of this result was received by the station on November 10.

## IV. Summary

In late November, we felt we were "green to go" and, given a nominal mission, were sure we could support in the expected manner, notwithstanding the new meaning of the word "final" when applied to the "last" entry sequence of events and uplink sweep message due to late shifting of the Small Probe assignments by the Project and problems experienced at JPL in the Navigation to Predict interface.

The events of December 9 are history now and need no elaboration – the mission was so close to nominal it was as though it were a simulation. The elation of success could be seen from one end of the station operations room to the other, and few events in the space program could compare to the feeling at the detection of the first Probe's RF signal. It appears that all data possible was successfully captured, and station personnel have the satisfaction of a difficult job well done.